Copepods of the genus Hermilius (Caligidae) parasitic on marine catfish of Kuwait, with a key to the species of Hermilius

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COPEPODS OF THE GENUS *HERMILIUS* (CALIGIDAE) PARASITIC ON MARINE CATFISH OF KUWAIT, WITH A KEY TO THE SPECIES OF *HERMILIUS*

Ju-shey Ho and Il-Hoi Kim
Department of Biological Sciences, California State University, Long Beach, California, 90840-3702, USA (JH); Department of Biology, Kangnung National University, Kangnung, 210-702, South Korea (IK)

ABSTRACT: Three species of caligid copepods (Siphonostomatoida) belonging to genus *Hermilius* Heller, 1865 were recovered from the giant marine catfish, *Arius thalassinus* Rüppell, taken from the Persian Gulf. They are *H. pyriventris* Heller, 1865; *H. longicaudus* n. sp.; and *H. longicornis* Bassett-Smith, 1898. *H. helleri* Pillai, 1963 is proposed to be relegated to the synonym of *H. pyriventris*. A key to the eight species of *Hermilius* is provided.

KEY WORDS: Parasitic Copepoda, Caligidae, *Hermilius*, Marine catfish.

INTRODUCTION

Hermilius Heller, 1865 is a genus of caligid copepods (Siphonostomatoida) parasitic exclusively on the gill filaments of marine catfishes (Ariidae). They are known to occur in the tropical and subtropical regions of the world oceans, except western Atlantic and eastern Pacific (Table 1). The catfishes of the Indian Ocean seem to be particularly rich in carrying the species of *Hermilius,* harbouring seven of the eight species reported so far. The only species occurring outside of the Indian Ocean is *H. youngi* Kabata, which is known so far only from the marine catfishes off Brisbane, Australia (Kabata 1964).

Table 1. Hosts and localities of the nine species of *Hermilius* Heller, 1865.

SPECIES	HOST	LOCALITY	AUTHOR
alatus Hameed	*Arius jella* Day (*Pseudarius jella*)	Trivandrum, India	Hameed, 1981
	Arius acutirostris Day	Trivandrum, India	Hameed, 1981
ariodi Prabha & Pillai	*Arius dussumieri* Valenciennes	Trivandrum, India	Prabha & Pillai, 1986
	(*Ariodes dussumieri*)	Bombay, India	Rangnekar, 1963*
helleri Pillai	*Arius jatius* (Hamilton) (*Pseudarius jatius*)	Trivandrum, India	Pillai, 1963; 1985 Prabha & Pillai, 1986
longicaudus n. sp.	*Arius thalassinus* Rüppell	Kuwait	present paper
longicornis Bassett-Smith	*Arius acutirostris* Day	Trincomalee, Sri Lanka	Bassett-Smith, 1898
	Arius dussumieri	Trivandrum, India	Pillai, 1963; 1985

	Valenciennes (*Ariodes dussumieri*)		
	Arius sp.	Colombo, Sri Lanka	Kirtisinghe, 1964
		Trivandrum, India	Pillai, 1961**
	Arius thalassinus Rüppell	Penang, Malaysia	Leong, 1985
		Kuwait	present paper
pseudari Hameed	*Arius jella* Day (*Pseudarius jella*)	Trivandrum, India	Hameed, 1981
pyriventris Heller	*"Arius acutus"*	Java	Heller, 1865
	Arius heudelotii Valenciennes	Mauritania	Brian, 1924
		off Nambia	Capart, 1959
	Galeichthys felicepes Valenciennes	Table Bay, South Africa	Barnard 1955
		Walvis Bay, Nambia	Capart 1959***
	Arius platystomus Day (*Pseudarius platystomus*)	Trivandrum, India	Pillai, 1963
	"Netuma macrocephalus"	Vipingo, Kenya	Cressey, 1974
	"Netuma thalassinus"	Vipingo & Diani, Kenya	Cressey, 1974
	Arius sp.	Vizakhapatnam, India	Cressey, 1974
	Tachysurus sp.	Philippines	Cressey, 1974
			Dojiri, 1983
	Arius thalassinus Rüppell	Penang, Malaysia	Leong, 1985
		Trivandrum, India	Pillai 1985
		Kuwait	Ho & Sey, 1996
	Arius maculatus (Thunberg)	Taiwan	Lin & Ho (in press)
tachysuri Pillai & Natarajan	*Tachysurus* sp.	Trivandrum, India	Pillai & Natarajan, 1977
youngi Kabata	*"Neoarius australis"*	Moreton Bay, Australia	Kabata, 1964
	"Netuma australis"	Moreton Bay, Australia	Kabata, 1964

Note: All scientific names of the fish hosts were confirmed with "Fish Base 99" on the internet. The current valid names are given above in the table. Those appear in the parenthesis are synonyms and those in the inverted commas are the names not found in "Fish Base 99".

* as *"Hermilius longicornis* Bassett-Smith, 1898".

** as *"Hermilius pyriventris* Heller, 1865".

*** as *"Hermilius armatus* sp. nov.".

This paper reports three species of *Hermilius* taken from three separate collections of the giant marine catfish, *Arius thalassinus* Rüppell, caught in the Persian Gulf. Although these three species of parasites were found on the same species of host, they were not found on the same individual. Seemingly, a parasitic exclusion is happening in this parasitism. Two of the three species are known from India, they are *H. pyriventris* Heller and *H. longicornis* Bassett-Smith, and the third species is new to science. Since *H. longicornis* is still poorly known, a full redescription is given to show certain fine structures that were not mentioned by previous workers.

In order to facilitate the future works on this genus of marine catfish-parasitizing copepods, a key to the known species is also provided.

MATERIALS AND METHODS

The catfishes were purchased from the market in Kuwait and examined in the laboratory for the copepod parasites, which were carefully removed and preserved in 70% alcohol. The subsequent microscopic studies of the parasites were made in a drop of lactic acid and examined with a compound microscope. Drawings were made with the aid of a camera lucida.

SYSTEMATIC ACCOUNT

***Hermilius pyriventris* Heller, 1865:**

Hermilius pyriventris Heller, 1865: 187; Bassett-Smith, 1899: 445; Brian, 1924: 32; Barnard, 1955: 100; Capart, 1959: 91; Yamaguti, 1963: Pillai, 1963: 181; Cressey, 1974: 236; Dojiri, 1983: 209; Leong, 1985: 50; Pillai, 1985: 412; Ho and Sey, 1996: 63.

Hermilius armatus Capart, 1959: 90.

Hermilius helleri Pillai, 1963: 187.

Material Examined.- 4 ♀♀ on gill filaments of the catfish, *Arius thalassinus* Rüppell, caught in the Kuwait Bay on 29 July 1993.

Remarks: This is the type species of the genus. It was first described from a marine catfish taken in Java (Heller, 1865) and subsequently found on the same family of fishes off both east and west coast of Africa, Kuwait, India, Malaysia, Philippines, and Taiwan (Table 1). Since the original description was sketchy, six full redescriptions with illustrations of dissected appendages have been made in the past by various authors based on the specimens collected from different regions of the world. They are Capart (1959) based on specimens from Nambia; Pillai (1963; 1985), from India; Cressey (1974), from Kenya; Leong (1985), from Malaysia; Dojiri (1983), from Philippines; and Lin and Ho (in press) from Taiwan. Although the original description does not show fine structures of the appendages, it is possible to tell that all of the subsequent redescriptions are dealing with the same species, except the two redescriptions by Pillai (1963) and Pillai (1985).

The exopod of leg 4 in Heller's (1865) original work was not illustrated separately by itself as seen in most of the modern descriptions of parasitic copepods. Nevertheless, it is clearly shown as 2-segmented rami tipped with 4 spines. However, it is understandable that the fourth spine in Heller's (1865) illustration found in Plate XVIII, Fig. 1a is in

essence representing a large pecten at the base of the innermost (third) terminal spine in side view. The illustrations of the same appendage in Pillai's two redescriptions show 1-segmented rami with different terminal armature. The first redescription (Pillai, 1963: 183) shows 1-segmented leg 4 exopod equipped with 4 equally developed large, terminal spines; but the later redescription (Pillai, 1985: 413) illustrates the same appendage as 1-segmented with 3 unequally developed terminal spines. Although the later case approaches closer to what is known for *H. pyriventris,* it still differs from the *H. pyriventris* redescribed by Cressey (1974), Dojiri (1983), Leong (1985), and Lind and Ho (in press) in having the middle (instead of the innermost) spine as the longest of the three terminal elements. Apparently, the identity of *H. pyriventris* from Trivandrum, India needs to be re-examined and clarified.

Hermilius helleri Pillai is a questionable species from India. In its original description given by Pillai (1963), *H. helleri* was distinguished from *H. pyriventris,* the closest congener, by having a "plumose" terminal claw on the "anal laminae" and a sternal furca "with long apically narrowed rami" (Pillai, 1963: 187). Undoubtedly, these differences warrant a status of new species. However, in Prabha and Pillai's (1986) redescription of *H. helleri,* these two distinguishing characteristics were changed and illustrated to be indifferent from *H. pyriventris*. Nevertheless, *H. helleri* was kept because it can be distinguished "by the general shape of the body and by the presence of two teeth on the shaft of the subchela of the maxilliped" (Prabha and Pillai, 1986: 40). Since these two amended species distinctions for *H. helleri* are found in the redescriptions of *H. pyriventris* provided by Cressey (1974), Dojiri (1983), Leong (1985), and Lin and Ho (in press), *H. helleri* Pillai is proposed to be relegated to the synonym of *H. pyriventris*.

As a common occurrence in parasitic copepods, the male of *Hermilius* is rare. It has been sighted so far only for *H. aridiodi* by Prabha and Pillai (1986) and for *H. pyriventris* by Cressey (1974), Pillai (1985), and Lin and Ho (in press). Hameed and Pillai (1972) reported two males from the gills of *Arius* sp. caught at Trivandrum, India. Since the two males were "collected along with females of *H. pyriventris*" (Hameed and Pillai, 1972: 213), they were closely compared with the male reported by Cressey (1974), Pillai (1985), and Lin and Ho (in press). Through this comparison, it was discovered that Hameed and Pillai (1972) were dealing with juvenile female and not the male. The antenna of their alleged males does not bear the typical sexual dimorphism (corrugated pads on second segment) found on the males of many caligid genera including *Hermilius*.

Hermilius longicaudus n. sp. (Figs. 1-2):

Material Examined.- 31 ♀♀ on gill filaments of the catfish, *Arius thalassinus* Rüppell, caught in the Kuwait Bay on 10 October 1996. Holotype and 22 paratypes have been deposited in the U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C. and remaining paratypes in the junior author's (IK) collection.

Female.- Body (Fig. 1A) 3.45 mm long, excluding setae on caudal rami. Cephalothorax with deep anteromedial notch and folded ventrally in lateral portion as typical in this genus. Genital complex large and more than twice longer than wide, 1.67x0.71 mm, tapering posteriorly or with nearly parallel sides. Abdomen (Fig. 1B) also more than twice longer than wide, 708x258 μm, and without indication of segmentation. Caudal ramus (Fig. 1C) about 1.5 times (83x55 μm) longer than wide, armed with 3

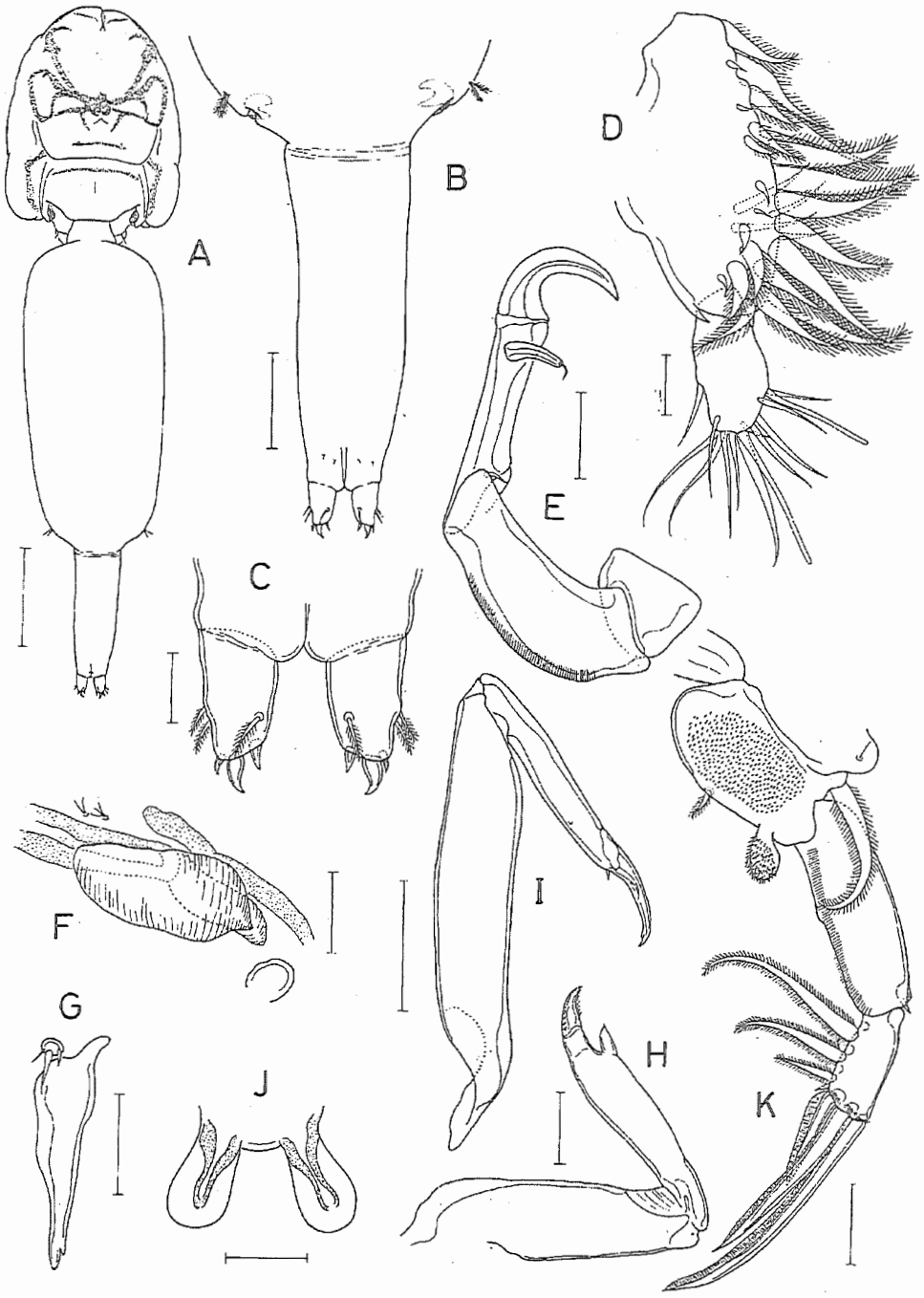

Fig. 1. *Hermilius longicaudus* n. sp., female. A. habitus, dorsal; B. abdomen, dorsal; C. caudal rami, dorsal; D. antennule; E. antenna; F. postantennary process; G. maxilule; H. maxilla; I. maxilliped; J. sternal furca; K. leg 1. Scale bars: A=0.5 mm; B=0.2 mm; C, E-G, K=50 μm; D, H, J=0.20 μm; I=0.1 mm.

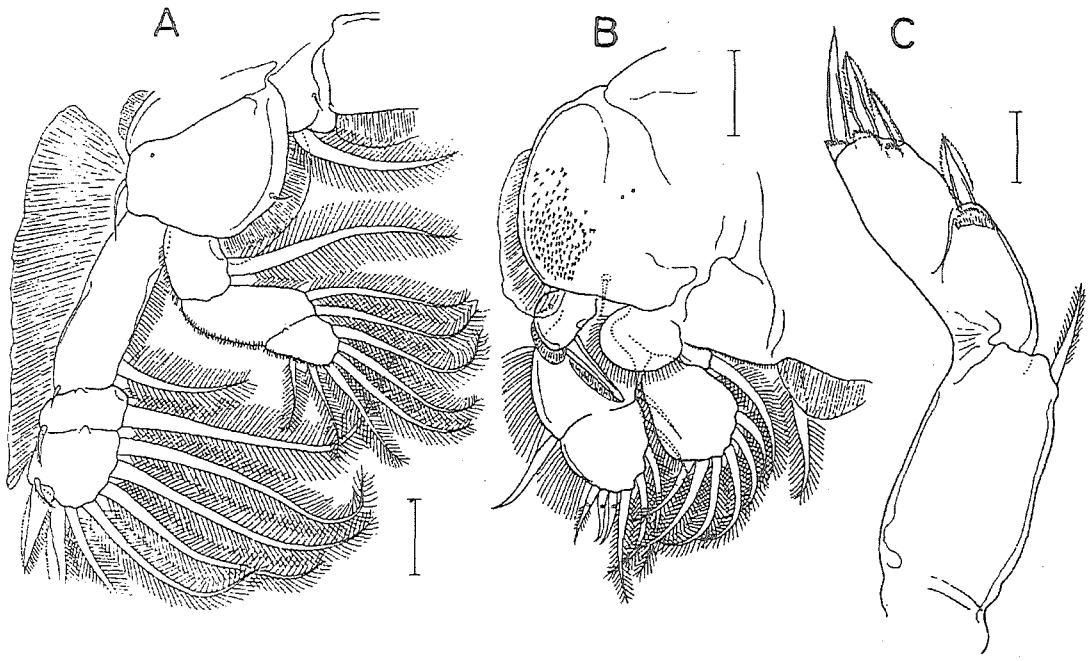

Fig. 2. *Hermilius longicaudus* n. sp., female. A. leg 2; B. leg 3; C. leg 4. Scale bars: A. B 50 µm; C=20 µm.

terminal, acuminate spines and 3 subterminal, plumose setae (2 on outer margin and 1 on medioventral surface).

Antennule (Fig. 1D) 2-segmented; proximal segment with 27 setae on anterodistal surface and a spine-like structure on posterodistal corner; distal segment with 11 subterminal seta on posterior margin and 11 setae plus 2 aesthetascs on distal margin. Antenna (Fig. 1E) 4-segmented; proximal segment smallest; 2nd segment largest, with striated outer margin and 1 small distal seta; 3rd segment slender, with a large distal, auxiliary process tipped with seta; 4th segment sharply pointed, curved claw. Postnatennal process (Fig. 1F) represented by 2 fleshy processes and small sclerotized knob. Mandible as typical in *Hermilius* comprising 3 segments with 12 teeth on medial margin of distal blade. Maxillule (Fig. 1G) comprising small papilla bearing 3 setules and long dentiform process with slightly forked tip. Maxilla (Fig. 1H) 2-segmented; proximal segment (lacertus) unarmed; subterminal canna on brachium smooth, but terminal calamus armed with spinules on both sides. Maxilliped (Fig. 1I) more slender than maxilla and 3-segmented; proximal segment (corpus) largest but unarmed; middle segment (shaft) with small, inner-terminal seta; terminal claw with basal seta and small subterminal tine. Sternal furca (Fig. 1J) weakly developed, tines broad spatulate and diverged.

Armature on rami of legs 1-4 as follows (Roman numeral indicating spines and Arabic numeral, setae):

	Exopod	Endopod
Leg 1	1-0; III, I, 3	(vestigial)
Leg 2	I-1; I-1; I, II, 5	0-1; 0-2; 6
Leg 3	I-0; I-1; 7	0-1; 6
Leg 4	I-0; III	(missing)

Leg 1 (Fig. 1K) protopod with large, plumose outer seta and another small, plumose inner seta in addition to spinules on ventral (anterior) surface; vestigial endopod a knob covered with setules; proximal segment of exopod with row of setules on inner margin and short spiniform seta at outer distal corner. Leg 2 (Fig. 2A) coxa small, with large, plumose inner seta on posterior edge; basis with small, outer simple seta, a small marginal inner seta in addition to inner marginal membrane; first exopodal segment long and bearing large outer, marginal membrane; outer margins of endopodal segments with spinules. Leg 3 (Fig. 2B) protopod (apron) with small outer and large inner plumose seta, membrane on outer edge, and patch of spinules in outer portion of ventral surface; outer flange on spine and swelling of first segment of exopod. Leg 4 (Fig. 2C) protopod with plumose outer seta; pectens on both expodal segments at insertion of each of 4 outer spines. Leg 5 represented by papila bearing 2 small setae located at posterolateral corner of genital complex anterior to genital pore (see Fig. 1B).

Remarks.- The most characteristic feature of the present species is the possession of a long abdomen, which is 2.75 times longer than wide. Of the eight currently known species, only *H. pseudari* Hameed approaches the present new species in this feature, all of the rest have their abdominal length/width ratio distinctly less than 2. Since Hameed (1981) did not give measurements in his description of *H. pseudari*, an exact length/width ratio is impossible to obtain. However, based on his illustration of the animal shown in Fig 4a, the ratio is about 2.17, clearly smaller than the new species. In addition, the differences are also found in the shape of the genital complex, structure of the dentiform process of the maxillule, and number of the terminal spines on leg 4 exopod. The last difference is noteworthy. *H. pseudari* is the only species of *Hermilius* allegedly bearing 4 (instead of 3) terminal spines on the exopod of leg 4.

Although postantennal process is a common structure found in many genera of caligid copepods, it is seldom mentioned in the works of *Hermilius*. When Dojiri (1983) redescribed *H. pyriventris,* he stated "postantennal process absent, but two irregularly shaped protrusions located in this area". Our studies of those "irregularly shaped protrusions" on the three species of *Hermilius* from Kuwait indicate that they are indeed the postantennal process. The difference in the appearance of this structure is very likely due to the differential development of attachment on the host's gill filament evolved in *Hermilius* - by way of "clasping" instead of "hooking". Like the present new species, the postantennal process in the type species, *H. pyriventris* Heller, comprises also two fleshy processes and 1 small, sclerotized knob.

***Hermilius longicornis* Bassett-Smith, 1898 (Fig.3):**

Hermilius longicornis Bassett-Smith, 1898: 80; 1899: 445; Rangnekar, 1963: 80; Pillai, 1963: 183; Yamaguti, 1963: 83; Kirtisinghe, 1964: 76; Pillai, 1985: 416. *Hermilius pyriventris*: Pillai, 1961: 123.

Material Examined.- 4♀♀on filaments of the catfish, *Arius thalasimmus* Rüppell, caught in the Kuwait Bay on 10 October 1996.

Female.- Body (Fig. 3A) 2.81 mm long, excluding setae on caudal rami. Cephalothorax generally as in *H. longicaudus*. Genital complex large, longer than carapace, slightly broadened distally and with flat sides; pair of small knobs on posteroventral surface between genital areas (Fig. 3B). Abdomen short (Fig. 3B), as long as wide, 212x212µm. Caudal ramus (Fig. 3C) about 1.65 times (90x55µm) longer than wide and armed with 6 plumose setae.

Antennule as in *H. longicaudus*. Antenna (Fig. 3D) 3-segmented; proximal segment smallest (not included in Fig. 3D); middle segment swollen, with a small distal seta; distal segment a long recurved, sharply pointed, strong claw, sharp auxiliary process in terminal region with a subterminal seta. Postantennal process (Fig. 3E) represented by a large fleshy lobe. Mandible as typical in *Hermilius*. Maxillule (Fig. 3F) comprising papilla bearing 3 setules and smooth, long dentiform process bearing narrow hyaline membrane distally. Maxilla (Fig. 3G) and maxilliped (Fig. 3H) generally as in *H. longicaudus*. Sternal furca (Fig. 3I) with tines longer than those in *H. longicaudus*.

Armature on rami of legs 1-4 generally as in *H. longicaudus*. Leg 1 (Fig. 3J) without spinules on ventral (anterior) surface of basis. Leg 2 (Fig. 3K) with weak outer spine on proximal and middle segments of exopod. Leg 3 (Fig. 3L) with stronger outer spine on middle segment of exopod. Leg 4 (Fig. 3M) exopod 1-segmented and armed with relatively shorter spines. Leg 5 not seen.

Remarks.- With the possession of 6 plumose setae (instead of 3 acuminate spines and 3 plumose setae) on caudal ramus, 3-segmented (instead of 4-segmented) antenna, and 1-segmented (instead of 2-segmented) exopod on leg 4, the specimens from Kuwait can be identified with *H. alatus* Hameed, 1981; *H. ariodi* Prabha and Pillai, 1986; and *H. youngi* Kabata, 1964, in addition to *H. longicornis*. However, they are identified with *H. longicornis* due to the structural difference exhibited in the terminal spines on the exopod of leg 4. While spine IV (the innermost terminal spine) in both *H. alatus* and *H. ariodi* is the longest one of the three, in *H. longicornis* it is spine III (the middle terminal spine). Leg 4 was not studied in detail by Kabata (1964); but, based on the differences observed in the genital complex, maxilla, and leg 3, the specimens from Kuwait cannot be identified with *H. youngi*. Hence, they are herein reported as *H. longicornis*.

H. longicornis has been redescribed five times since the publication of its original description in 1898. They were provided by Pillai (1961, 1963, 1985), Rangnekar (1963), and Leong (1985). However, we concur with Prabha and Pillai (1986: 39) that Rangneker's (1963) "*Hermilius longicornis* Bassett-Smith, 1898" is in essence a synonym of *H. ariodi* Prabha and Pillai, 1986. The resemblance of the genital complex, sternal furca, and relative lengths of spines on leg 4 exopod are supportive of Prabha and Pillai's (1986) relegation of Rangnekar's (1963) *H. longicornis*.

Key to the species of *Hermilius* Heller, 1865:

Pillai (1985) and Leong (1985) have constructed a key to the species of *Hermilius*. Since both keys dealt with only five species and are obsolete, a new key is thus called for. The characteristics employed in Leong's (1985) key is considered better than those utilized by Pillai (1985), encompassing more appendage structures and less general

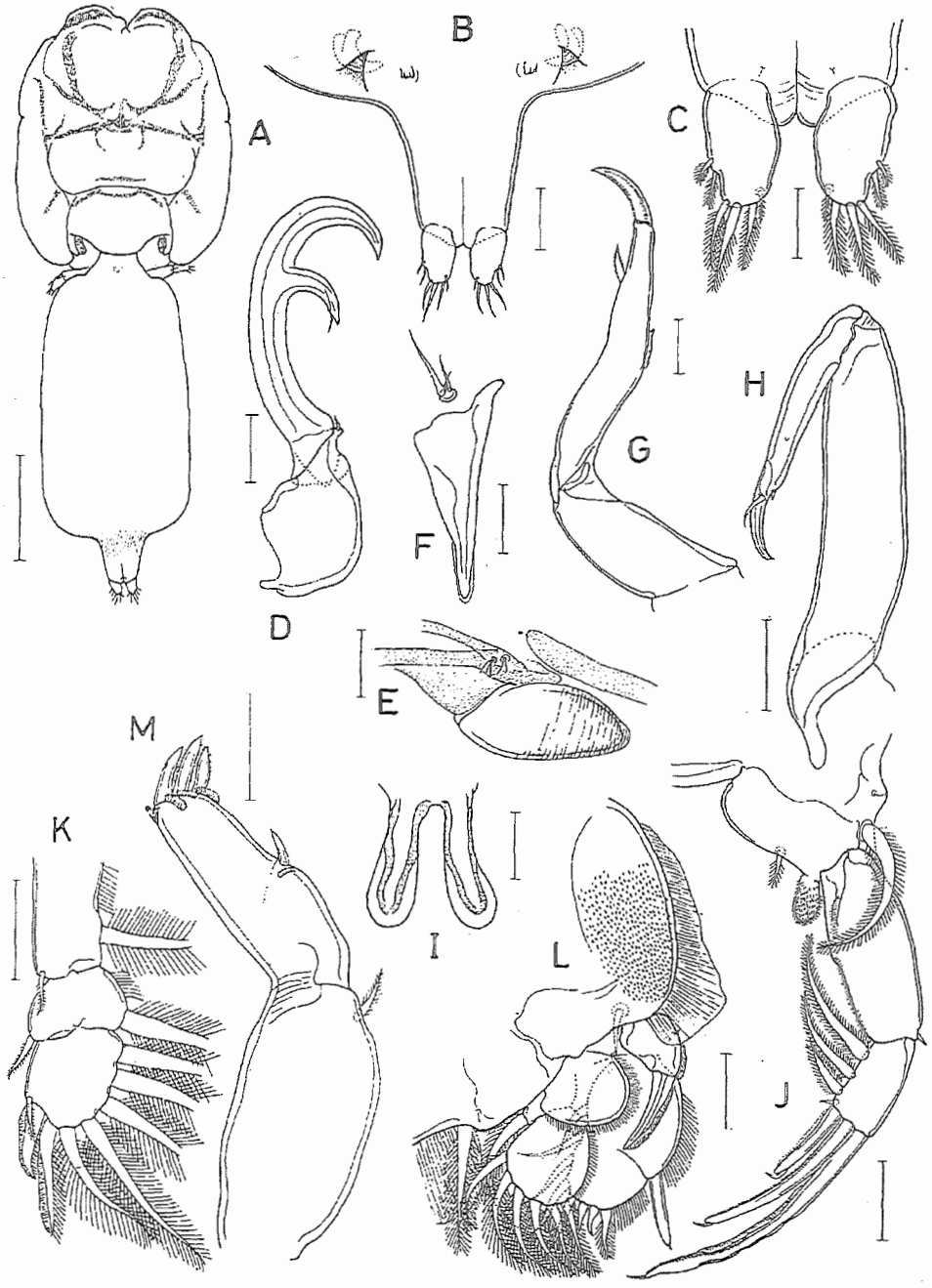

Fig. 3. *Hermilius longicornis* Bassett-Smith, female. A. habitus, dorsal; B. abdomen, ventral; C. caudal rami, ventral; D. antenna; E. postantennary process; F. maxillule; G. maxilla; H. maxilliped; I. sternal furca; J. leg 1; K. exopod of leg 1; L. leg 3; M. leg 4. Scale bars: A=0.5 mm; B, D, H=0.1 mm; C, E, F, J-M=50 μm; G, I=20 μm.

appearance of the genital complex and cephalothorax which are variable sometimes with the state of fixation (preservation) of the specimen. In Leong's key, leg 4 was stated either 3-segmented or 2-segmented. But, based on the modern concept of copepodology, this expression is inappropriate.

As in many genera of caligid copepods, the proximal segment of leg 4 in *Hermilius* is a protopod (bearing a plumose outer seta, see Fig. 2C, or Fig. 3M) and the next segment, or next two segments represent the outer ramus - the exopod. Therefore, the various numbers of segments in this case is referring to the exopod and not the entire leg. Accordingly, the word "exopod" should be included in the character state discrimination and the variation of segment number is to be changed to either 2-segmented or 1-segmented.

The exopods of leg 4 in the species of *Hermilius* are known to carry 3 or 4 terminal spines at the distal end of the ramus. In the case of a 1-segmented exopod there is a subterminal spine and in a 2-segmented exopod, an outer spine on the first segment. This outer or subterminal spine is called Spine I and the 3 terminal spines are called Spine II, Spine III, and Spine IV in an order from lateral (outer) to medial (inner). The structure of and armature on the exopod of leg 4 are characteristic to the species of this genus.

As mentioned above, the male is known only for two species of *Hermilius, H. ariodi* and *H. pyriventris,* the key provided below is therefore intended for identification of the female. Refer to the illustrations mentioned after the structures when using this key.

1a. Claw of antenna segmented distal to auxiliary process (Fig. E); caudal ramus with 3 acuminate process and 3 setae (Fig. 1C) 2
1b. Claw of antenna not segmented distal to auxiliary process (Fig. 3D); caudal ramus with 6 setae (Fig. 3C) 5
2a. Abdomen long, at least 2 times longer than wide (Fig. 1A) 3
2b. Abdomen short, at most 1.5 times longer than wide (Fig. 3A) 4
3a. Leg 4 exopod with 3 terminal spines (Fig. 2C); dentiform process of maxillule with subterminal tine ..... *longicaudus* N. SP.
3b. Leg 4 exopod with 4 terminal spines; dentiform process of maxillule without subterminal tine (Fig. 3F) ..... *pseudari* Hameed, 1981
4a. Leg 4 exopod 1-segmented and Spine I situated close to Spine II ..... *tachysuri* Pillai and Natarajan, 1977
4b. Leg 4 exopod 2-segmented and Spine I situated far apart from Spine II (Fig. 2C) ..... *pyriventris* Heller, 1865
5a. Leg 3 exopod 3-segmented and carrying 7 setae on distal segment (Fig. 3L) 6
5b. Leg 3 exopod 2-segmented and carrying less than 7 elements on distal segment 7
6a. Spine III on leg 4 exopod longest among terminal spines and Spine I shorter (smaller) than Spine II (Fig. 3M) ..... *longicornis* Bassett-Smith, 1898
6b. Spine IV on leg 4 exopod longest among terminal spines (Fig. 2C) and Spine I longer (larger) than Spine II ..... *alatus* Hameed, 1981
7a. Tines of sternal furca with marginal membrane and spatula like (Fig. 1J); 3-segmented rami on leg 2 (Fig. 2A) ..... *ariodi* Prabha and Pillai, 1986
7b. Tines of sternal furca long, bluntly pointed and without marginal membrane; 1-segmented rami on leg 2 ..... *youngi* Kabata, 1964

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